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MARLS FOR LIMING SOILS

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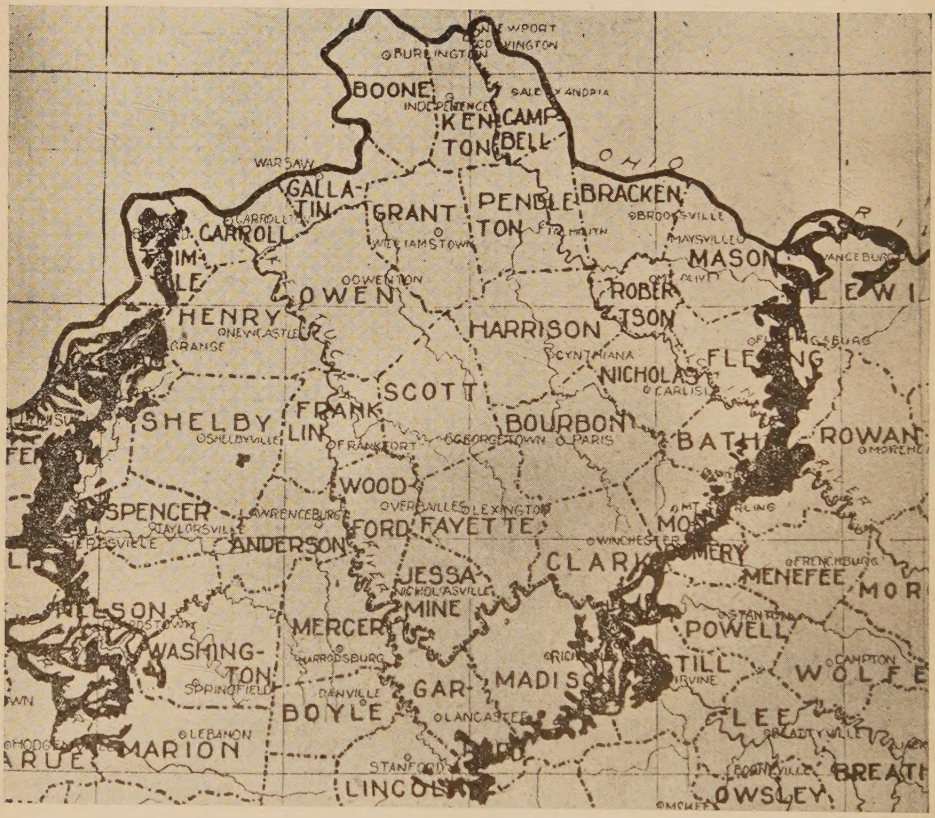

Silurian out-crop shown in black.*

*Photographed from map on page 55, Series 5, Bulletin 2, of the Kentucky Geological Survey.

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MARLS FOR LIMING SOILS

By S. C. JONES

INTRODUCTION

During the brief period of little more than 100 years, thru the prodigal system employed by our farmers, the virgin fertility has been cropped out of much of our soil and today we have thousands of acres of land under cultivation that are really being farmed at a loss. Already many acres are being abandoned and unless the owners of these unprofitable acres face about and do many things that they have not done, this process of abandoning land will continue. The continued cultivation of these lands to tobacco and grain crops, without the growth of sufficient legumes in the crop rotations and with the wasteful utilization of crop residues and manures, has resulted in a serious deficiency of nitrogen, which is greatly limiting crop production in most Kentucky soils. These cropping practises have also resulted in many of our soils becoming too acid for legumes, especially clovers and alfalfa, to be grown successfully unless the land is first limed. Even such legumes as cowpeas, soybeans, and Japan clover, which make a fair growth on acid soils, are made to yield from one-third to one-half more when lime and phosphate are applied. These lands cannot be built up economically unless legumes are grown and legumes cannot be grown successfully unless these lands are limed or limed and fertilized with phosphate. Fortunately many farmers have been using phosphate in commercial fertilizers or in other forms for many years, but as yet lime has been used in only a limited way. Information furnished from

some 70 counties by county agents reveals the fact that in these counties only 40,000 tons of ground limestone were used in 1923. Therefore it is safe to say that at most not more than 60,000 tons of ground limestone were used on the farms of Kentucky in 1923, a very small fraction of what should be used.

In order to emphasize the importance of lime, and of lime and phosphate on our soils, we are giving below a brief summary from the results from the use of lime and lime and phosphate in a four-year rotation of corn, soybeans, wheat and clover on six of the oldest experiment fields in different parts of the state outside the Bluegrass region. In these experiments ground limestone has been used at the rate of 2 tons per acre and acid phosphate at the rate of 800 pounds per acre per rotation for the first two rounds of the rotation. After that, lime is left off and phosphate is reduced to half the original application. In the computations, corn is valued at 80 cents per bushel, wheat at $1.00 per bushel and hay at $20.00 per ton.

Average Results from the Use of Limestone, Acid Phosphate, and Limestone and Acid Phosphate on 6 Kentucky Experiment Fields.

CROPS	Crop Increase and Value per Rotation		
	Limestone	Acid Phosphate	Limestone and Acid Phosphate
Corn. Average of 58 crops. Bu. per A.	6.6	5.5	13.9
Soybean hay. Average of 53 crops. Lbs. per A	562.	497.	1306.
Wheat. Average of 42 crops. Bu. per A	1.8	2.7	8.
Clover hay. Average of 41 crops. Lbs. per A	910.	516.	2027.
Value of increase. Dollars	21.80	17.23	52.45
Cost of treatment. Dollars	5.00	10.00	15.00
Net gain per A. Dollars	16.80	7.23	37.45

Until the recent discovery of the value of calcareous clays or marls as a source of lime for our soils, ground limestone and

burned lime were the only lime materials used on Kentucky soils. Now we know that ground limestone will continue to take first place, with marls taking second and burned lime third.

DISCOVERY OF THE VALUE OF SILURIAN MARLS FOR LIMING SOILS

During the past half century, geologists have described and mapped the rocks of the Silurian formation; in fact, they have written volumes dealing in detail with the characteristics of the various limestones, shales and clay beds making up these formations in Kentucky. Altho the analyses in these reports show that some of these clays are rich in calcium and magnesium carbonates, and some of the earlier geologists refer to them as being valuable fertilizers, yet it is only with the recognition of the need for the use of lime on our soils that the agricultural value of these marl beds, occurring so generally distributed in association with the Silurian rocks, has become known.

The writer, on September 20, 1923, while working with Mr. C. L. Hill, County Agent of Nelson County, observed that sweet clover and alfalfa were growing luxuriantly on the slopes and flats below these marl beds. Commenting to Mr. Hill upon this observation, he made known the fact that he had recently had two samples of these marls analyzed at the Experiment Station and that one of them contained about 58 per cent of calcium and magnesium carbonates. With these facts, a further investigation of these marls was begun immediately. Samples were collected from various outcroppings of the extensive marl beds in different parts of Nelson County, which on analysis were found to be rich in calcium and magnesium carbonates.

On September 26, the writer visited Lincoln County and was informed by Mr. C. B. Elston, County Agent of Lincoln County, that one farmer in his county, Mr. J. T. Rigsby, had begun the previous year to apply these marls to his land. On

visiting Mr. Rigsby's farm it was found that he had limed about 8 acres of land, then in corn, with Silurian marls. Mr. Rigsby stated that the county agent of Garrard County, several years previously, had collected samples of marls from his old farm two miles north of Preachersville in the southern edge of Garrard, which, when analyzed were found to be richer in calcium and magnesium carbonates than the Nelson County marls. Mr. Rigsby further stated that still more recently his brother, while a student at Berea College, had analyzed samples of marls from the same locality and found practically the same content of these constituents.

Since learning these facts, field and laboratory studies of the calcareous clay or marl beds found in the Silurian formation in some twenty counties in Kentucky have been made, with a hope that these calcareous clays might contain lime enough to take the place of ground limestone or burned lime for liming the soils in the communities where the beds are found. These hopes have been fully realized, as in every county where the Silurian rocks have been studied, more or less extensive marl beds have been found, rich enough in calcium and magnesium carbonates to be economically used in liming soils.

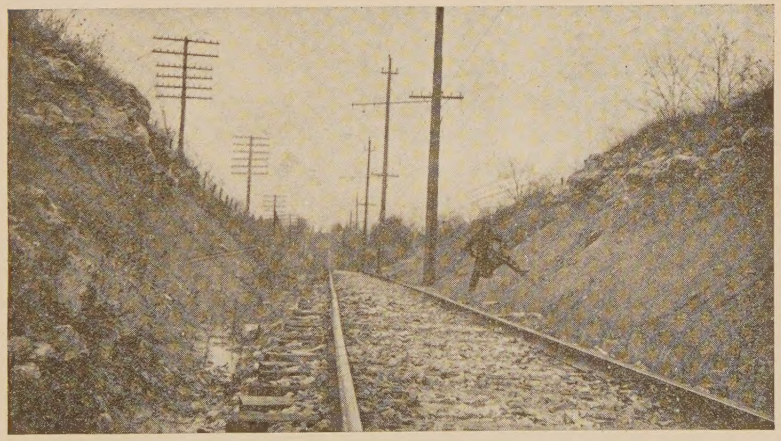
LOCATION OF THE SILURIAN FORMATION

The Silurian formation in Kentucky is exposed, to a greater or less extent, in some twenty-four counties lying immediately around the border of the Bluegrass Region, from Lewis County on the Ohio River on the east to Jefferson, Oldham and Trimble counties on the Ohio River on the west, except a section including a part of Marion, all of Boyle and a part of Lincoln counties. These formations continue from Lewis County north into Adams County, Ohio, and on thru the northwestern part of Ohio. Also they cross the Ohio River from Trimble County into Jefferson County, Indiana. The writer with Mr. Dodridge, County Agent of Jefferson County, Indiana, collected five samples of marls from just north of Madison.

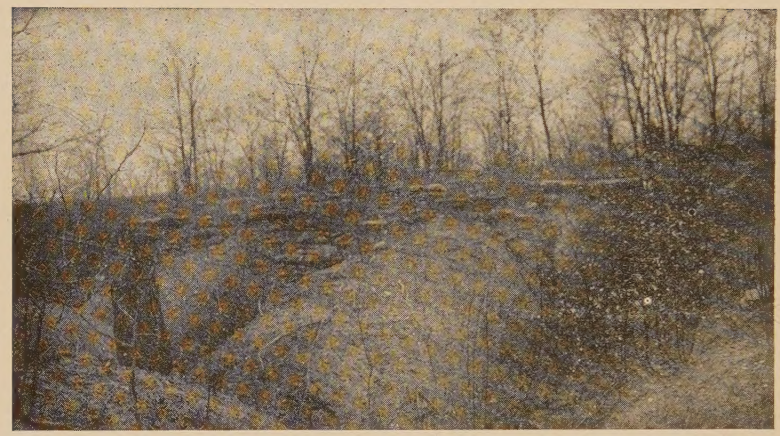
It may be seen from the accompanying map that a number of these counties, namely, Trimble, Oldham, Jefferson, Bullitt, Nelson, Lincoln, Garrard, Madison, Estill, Clark, Montgomery, Bath, Fleming and Lewis counties, contain large areas where the Silurian rocks furnish the soil formations and surface outcroppings, while minor areas are found in a number of other counties, as shown in the map. The total area representing the Silurian formations is 900 square miles. The soils in more than half of this area are badly in need of lime, while the adjacent territory (Devonian and Waverly soils) contains hundreds of thousands of acres even more in need of lime.

CHARACTER OF THE SILURIAN FORMATION

The Silurian formation is made up of beds of limestone containing varying amounts of calcium and magnesium carbonates, ranging in thickness from locality to locality and at different horizons from a few feet to some 40 feet in the thickest beds. These limestones are interbedded with clay or marl beds that range in thickness from a few feet in some sections to 40 to 100 feet in others.



No. 1. Upper marl bed 12 ft. thick (Waldron Shale) just west of Judson Station on Louisville-Shelbyville Interurban line in Jefferson County. Sample from this bed contained 60.1 per cent calcium carbonate.



No. 2. Exposure of same bed as No. 1 from 200 feet south in pasture. Typical field exposure. Shows sweet clover growing in marl bed.

The marls contain both magnesium and calcium carbonate with clay, sand and other constituents such as calcium sulfate, magnesium sulfate with potash in the form of silicate, in many instances.

These marls weather very readily and extensive exposures are often seen in the form of badly gullied or barren, denuded lands that are considered by the owners as worthless possessions. Extensive areas of this kind are found in parts of Lincoln, Garrard and Madison counties, In fact, such exposures, to a greater or less extent, are easily found on the hillsides and along the roadsides in every county where these marl beds occur.

In the limited investigation in other geological formations, marls of varying thickness and neutralizing value ranging from poor to rich have been found in the Cincinnatian, Trenton and Chester formations, which a further investigation may prove of value, especially for local use in liming soils in the localities where the marls occur.

The samples of marl were analyzed by the Chemistry Department of the Experiment Station. Calcium and magnesium carbonates were not determined separately, but only the neu-

tralizing value, as compared with calcium carbonate. The figures in the table may be taken as representing the relative value of the marls for agricultural use as compared with pure limestone.

Neutralizing Value of Marls from Counties Surveyed, Expressed as Calcium Carbonate.

COUNTY	No. Samples Analyzed	Per Cent Neutralizing Value		
		Lowest	Highest	Average
Bath	11	7.3	48.0	32.6
Bullitt	3	38.5	74.3	66.4
Clark	6	8.5	71.9	35.7
Estill	10	2.6	37.7	10.2
Fleming	15	3.5	49.8	28.1
Garrard	7	46.5	63.8	55.9
Henry	3	58.3	61.1	59.4
Jefferson	9	35.0	73.3	60.2
Lewis	9	7.5	43.3	30.0
Lincoln	17	20.0	74.1	51.7
Madison	11	19.3	66.3	54.4
Marion	1		60.1	
Mason	4	26.5	41.5	35.5
Montgomery	10	32.0	70.1	48.6
Nelson	23	17.0	69.3	43.1
Oldham	11	42.8	87.1	58.6
Pulaski	2	57.3	64.3	60.8
Shelby	3	27.8	71.1	50.1
Trimble	4	31.3	67.6	51.9
Jefferson, Ind.	5	39.5	70.1	55.1

It will be seen from the tabulation that the marls from Estill County are much lower in neutralizing value than those from any other county. The samples collected in Estill were practically all from what is known as the Estill clay bed (very low in lime) which outcrops in the central part of the county. This bed is apparently locally developed but has a maximum thickness of 60 feet or more. On the west side of Estill County

will be found marl beds outcropping lower down in the formation which are much richer in lime. Only one sample was collected from the lower beds. Its neutralizing power was equal to 37.7 per cent of calcium carbonate. The Estill, or poorer, beds are also developed in the counties north of Estill County. Several samples from these poor beds are included in those from Clark, Fleming, Bath and Lewis counties. For the most part, the richer marls are found in the counties on the west side of the Bluegrass Region. However, we have found rich marls in Lincoln, Garrard, Madison and Montgomery counties.

MARLS OF THE UPPER WAVERLY FORMATION

About March 1, 1924, the county agent of Green County, Mr. J. H. Atkerson, reported the discovery of marl in Green County. A few weeks later, the writer visited this county and neighboring counties and found quite extensive deposits of marls in certain sections.

These marl beds occur in the Upper Waverly (Harrodsburg Limestone) Limestone. The Harrodsburg limestone takes the name from a typical outcropping of this formation at Harrodsburg, Monroe County, Indiana. This formation is found in some twelve or fifteen counties in south central Kentucky and in several counties in southern Indiana.

The thickness of the Harrodsburg formation in southern Kentucky ranges from a few feet to probably 200 or more feet. In Green, Adair, Taylor and Larue Counties, two or more shale beds are interbedded in the Harrodsburg formation, varying from 10 to 20 or 30 feet, which, on exposure, weather very readily into a light yellow or bluish, soft calcareous or marly material. Samples collected from Adair, Green, Larue and Taylor Counties and analyzed by the chemistry department of the Experiment Station have the following values, expressed as calcium carbonate.

COUNTY	No. Samples Analyzed	Per cent Neutralizing Value		
		Lowest	Highest	Average
Adair	5	14.5	41.5	33.0
Green	7	22.5	51.5	27.9
Larue	5	33.3	53.8	41.0
Taylor	15	17.5	52.5	36.4

No doubt more or less marl will be found in a number of other counties in southern Kentucky when further investigations are made.

MARLS AS COMPARED WITH GROUND LIMESTONE

The beginning of the use of ground limestone for acid soils is comparatively recent, whereas marls have been used for this purpose in European countries for centuries. In fact it is claimed that the beneficial effect of heavy applications of marl made on soils a century ago is still in evidence.

The chief advantage of marls over ground limestone in liming soils is that they can be dug out and spread without grinding, thus entailing no expense on the part of the farmer other than his own effort, especially when found on his own farm. If obtained from his neighbor's farm, the expense should not be much greater.

As these marls contain on an average about one-half as much lime as ground limestone, they should be spread at about twice the rate of ground limestone. In other words, where two tons of ground limestone are to be used the marls should be spread at the rate of four tons per acre. Spread at this rate, the marls should in fact be more efficient than the ground limestone because the particles making up the marls are smaller than those making up ground limestone.

HOW TO SPREAD MARL.

Marl can be spread very conveniently and very rapidly from a wagon by hand with shovels. When heavy applications are to be made (4 to 5 tons per acre) a manure spreader may be very conveniently used. Any up-to-date lime spreader, that is, one that will spread wet lime or wet ground limestone, should successfully spread marl, by first screening out any small limestone fragments that may occur in the marl.

Inasmuch as there are tens of thousands of acres of acid lands in the Silurian area and thousands more on the border that are seriously in need of lime, 100,000 tons of marl should be spread on the farms in these counties in 1924, with a substantial increase in the use each succeeding year.

HOW TO DISTINGUISH A GOOD MARL FROM A POOR ONE.

1. The marl that is sandy looking or granular, with a sandy or grandular feeling, is much richer in the neutralizing elements than one that has a smooth or soap-stony feeling and a slick or glossy appearance.

2. When a few drops of hydrochloric (muriatic) acid are poured on a good marl it effervesces or bubbles vigorously, while there is little or no bubbling when the acid is poured on a poor marl.

3. If in doubt as to the value of a marl, samples should be sent to the Experiment Station for analysis.

ACKNOWLEDGMENT.

The chemical tests were made by Messrs. Averitt and Iler, of the Chemistry Department of the Experiment Station.